Influence of Diking and Climate on Salinities in Gilbert and Gunnison Bays of the Great Salt Lake

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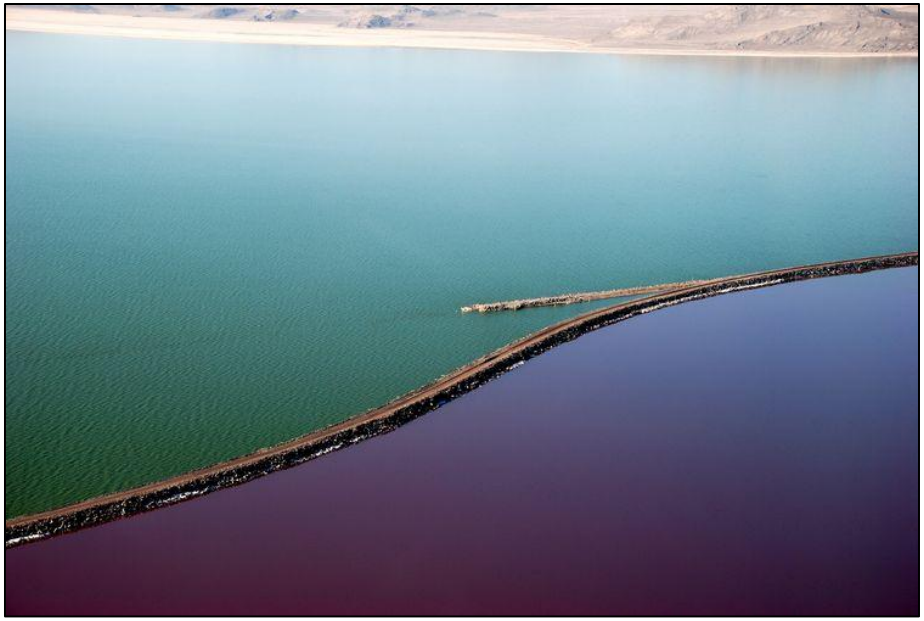

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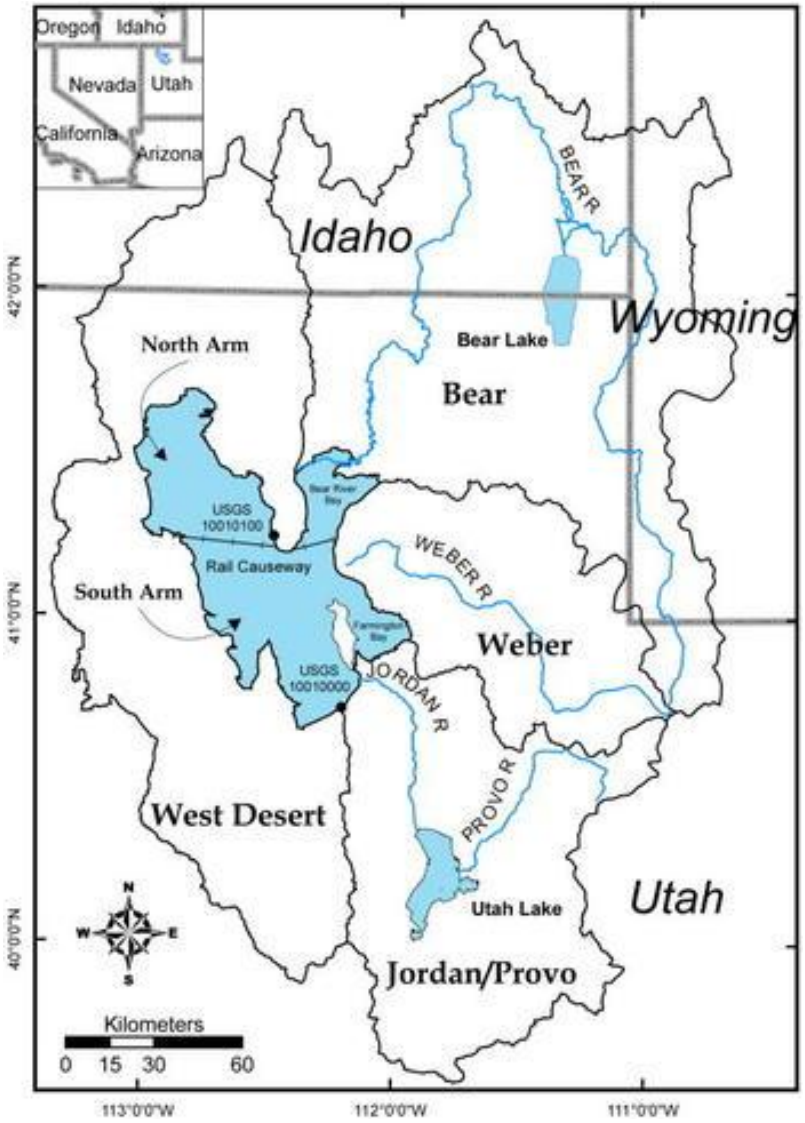
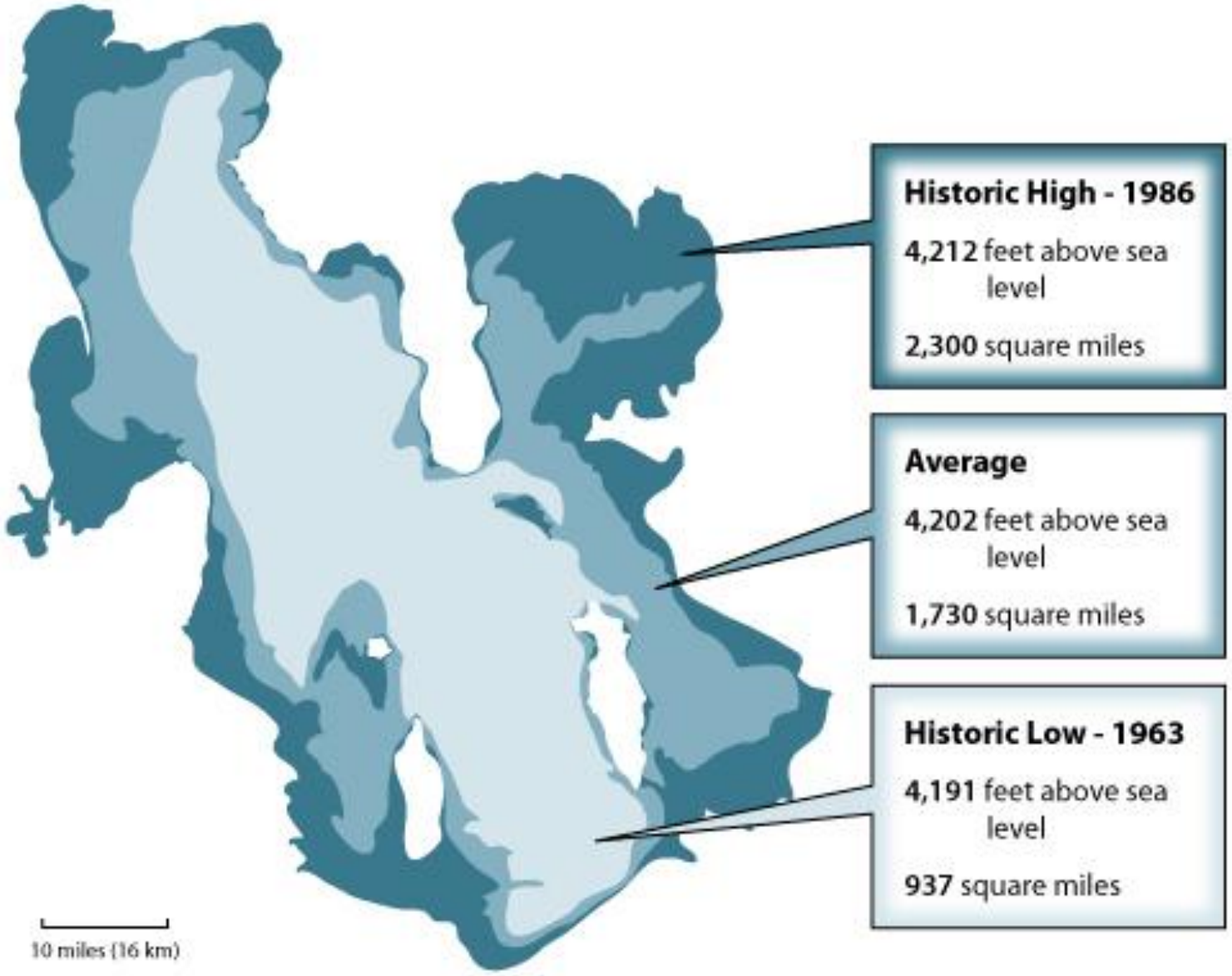
Outline

- Historic range of GSL level
- Anticipated climate changes
- Diking history
- Estimated whole lake elevation and salinity
  - Climate change sensitivity analysis
- Dike management opportunities

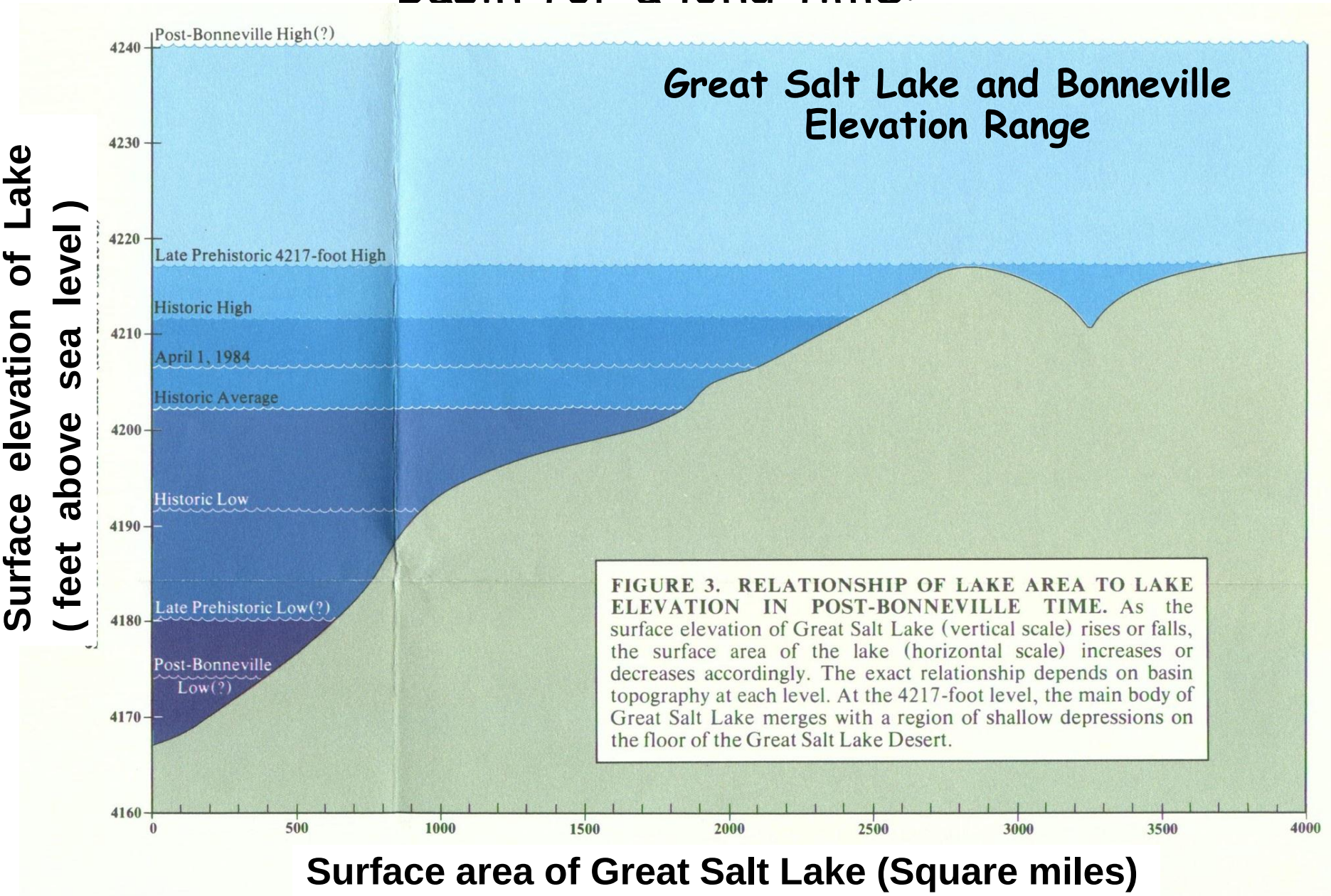


Mohammed and Tarboton, 2011

Great Salt Lake Elevation Range



Reminder - Climate change has been occurring in the basin for a lona time:



Surface inflow ~ 64%

Groundwater ~ 2.3%

Direct precip ~ 33%

~ 99%

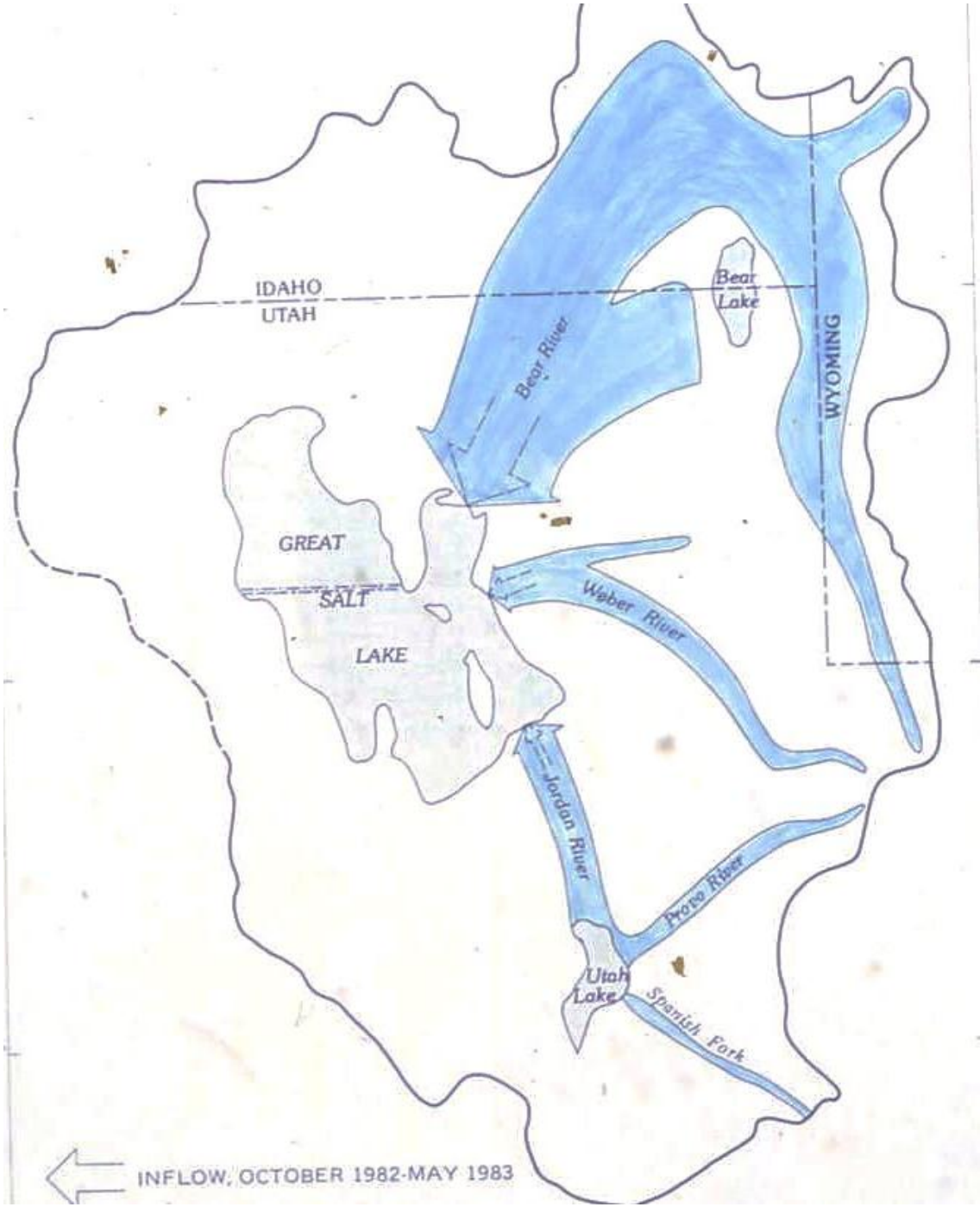
Major surface inflows:

Bear River ~ 55%

Weber River ~ 12%

Jordan River ~ 26%

~ 93%



Anticipated Climate Change

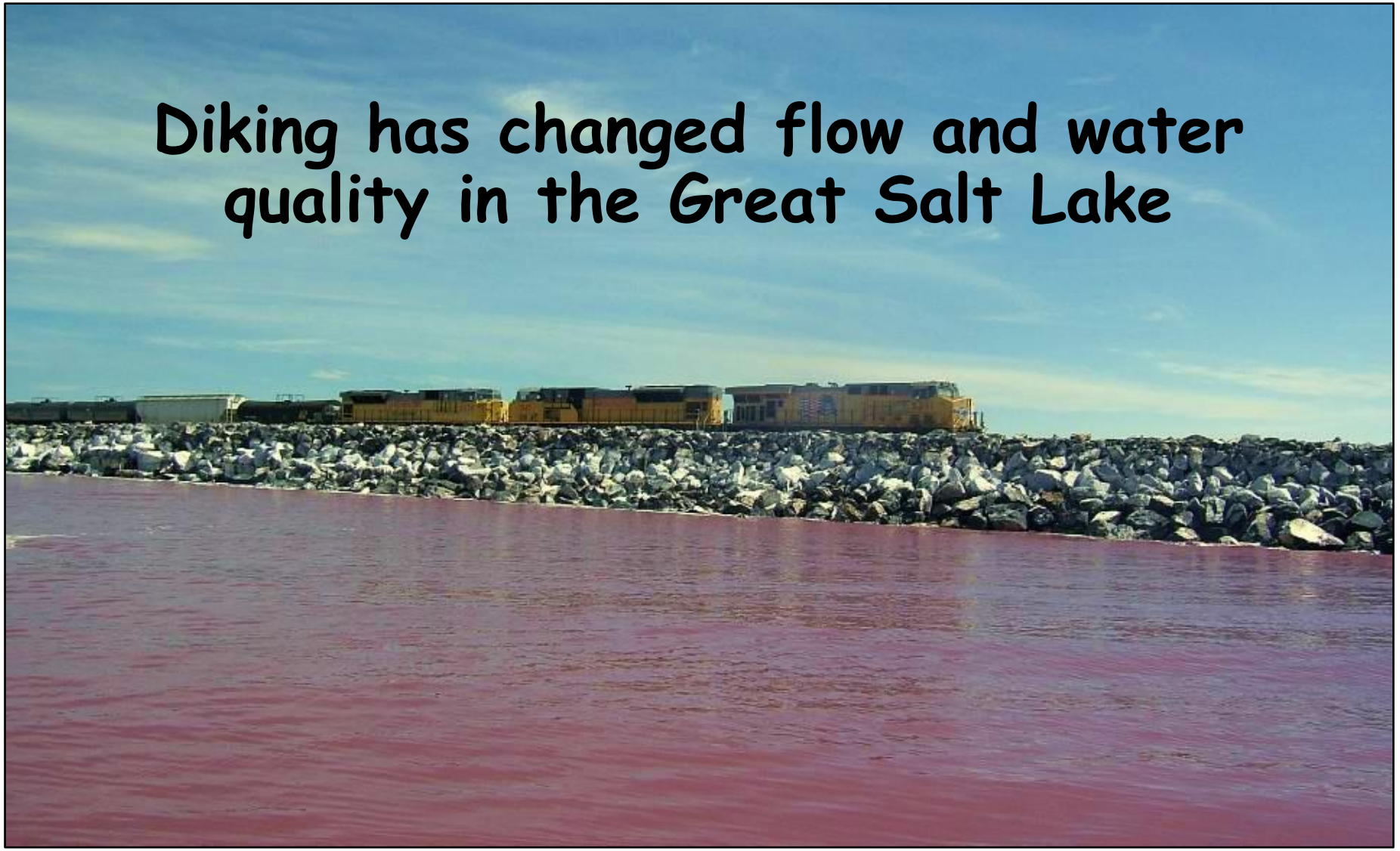
- Air temperature ↑ 3 - 5°C by 2100
  - Snowfall to rainfall
  - Changing runoff timing
  - Increasing evapotranspiration
    - Increased lake evaporation
  - Winter flooding & drier summers
- Precipitation possibly increasing in northern Utah

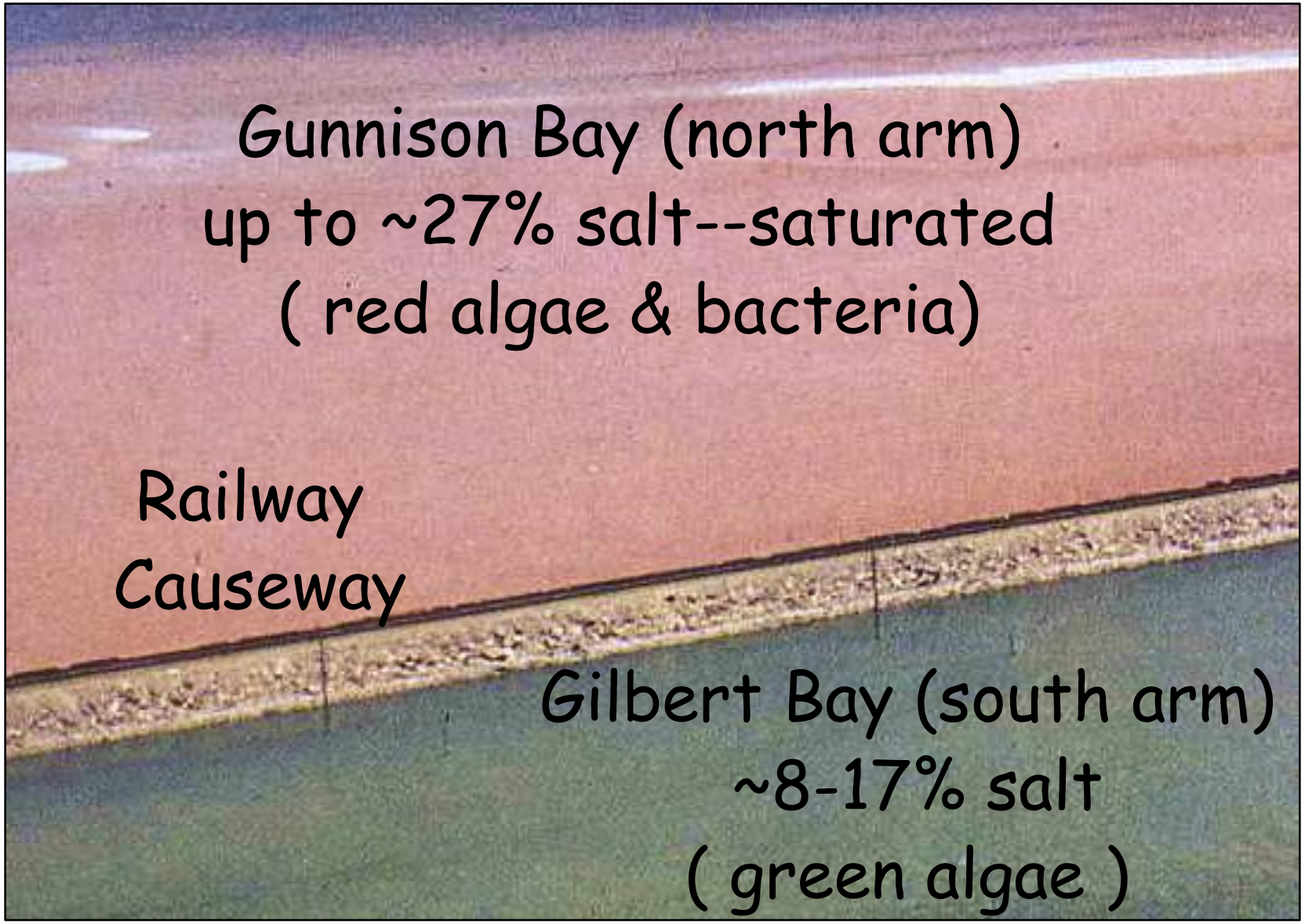
Will we have
a *salt flat* like the
Aral Sea?

The return of
Lake Bonneville?

Or variability between both those conditions?

Solid Fill Railway Causeway - 1959

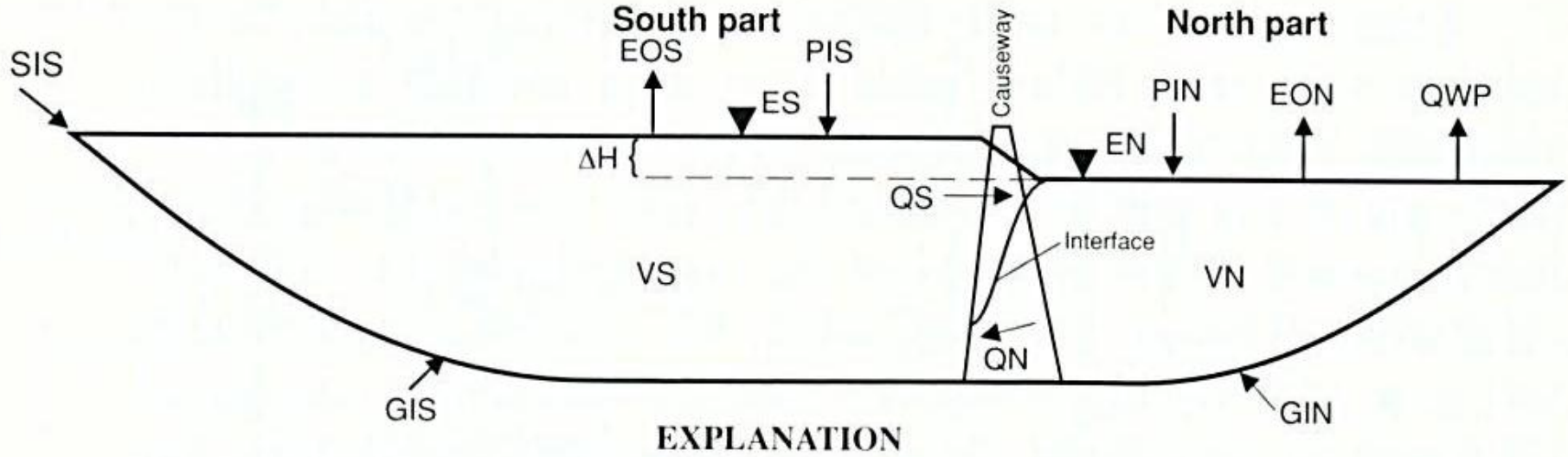




Oceans 3.5% salt

Farmington Bay auto causeway - 1969

Dikes alter water and salt balance



EXPLANATION

ES	Water-surface altitude of the south part	ΔH	Difference between water-surface altitude of south and north parts
EN	Water-surface altitude of the north part	PIS	Precipitation on south part
EOS	Evaporation from south part	PIN	Precipitation on north part
EON	Evaporation from north part	QS	Total south-to-north flow through causeway
GIS	Ground-water inflow to south part	QN	Total north-to-south flow through causeway
GIN	Ground-water inflow to north part	SIS	Surface-water inflow to south part
QWP	Withdrawals to West Pond	VS	Volume of the south part
		VN	Volume of the north part

Figure 5. *Schematic diagram of water balance for Great Salt Lake, Utah (Loving, Waddell, and Miller, 2000).*

Dikes alter water and salt balance

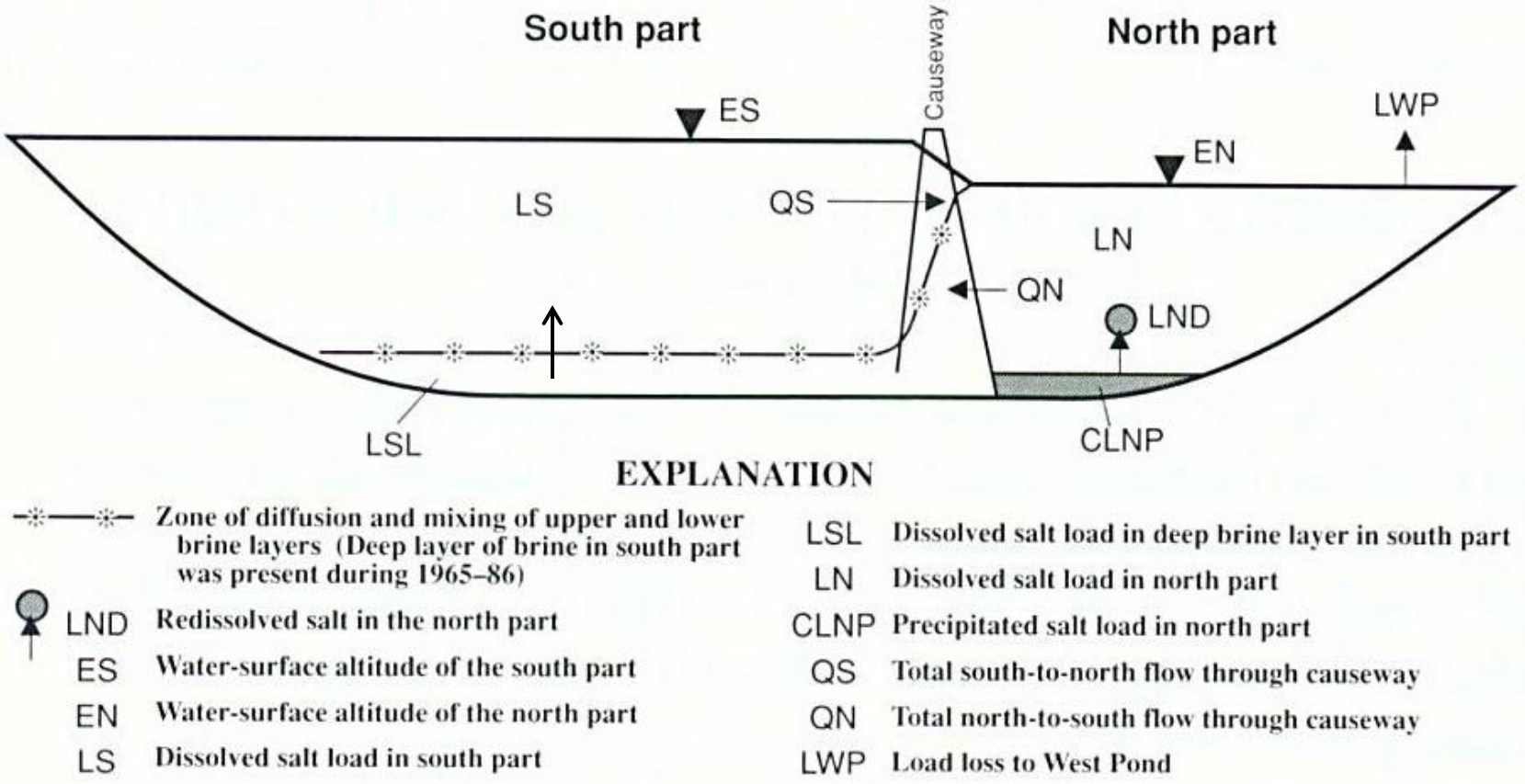
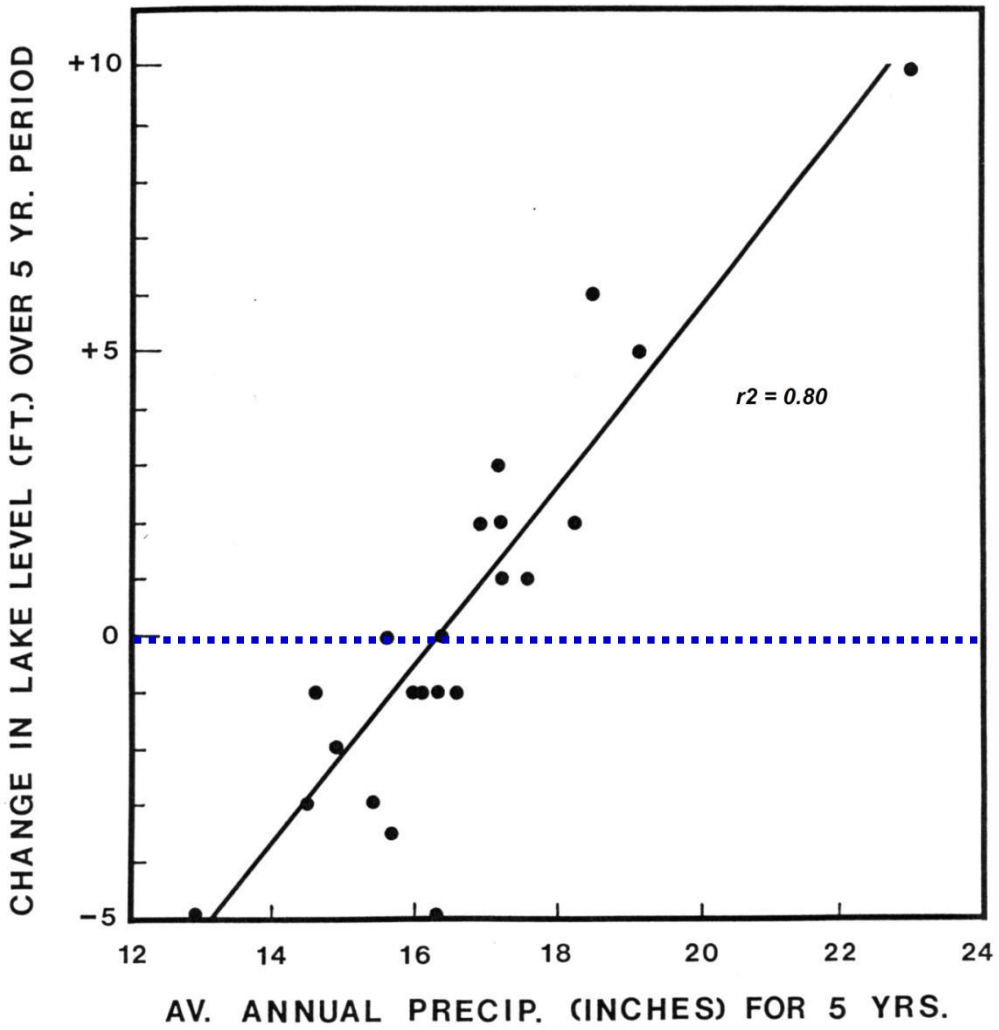


Figure 6. *Schematic diagram of salt balance for Great Salt Lake, Utah (Loving, Waddell, and Miller, 2000).*

Modeling Needed

- Climate→runoff
- Runoff – lake level→lake area
  - » **salinity**
  - » **evaporation**
  - » **lake level**
- Management model of Bear, Weber, Jordan/Provo
  - » **Land use change**
  - » **Water diversion and regulation**

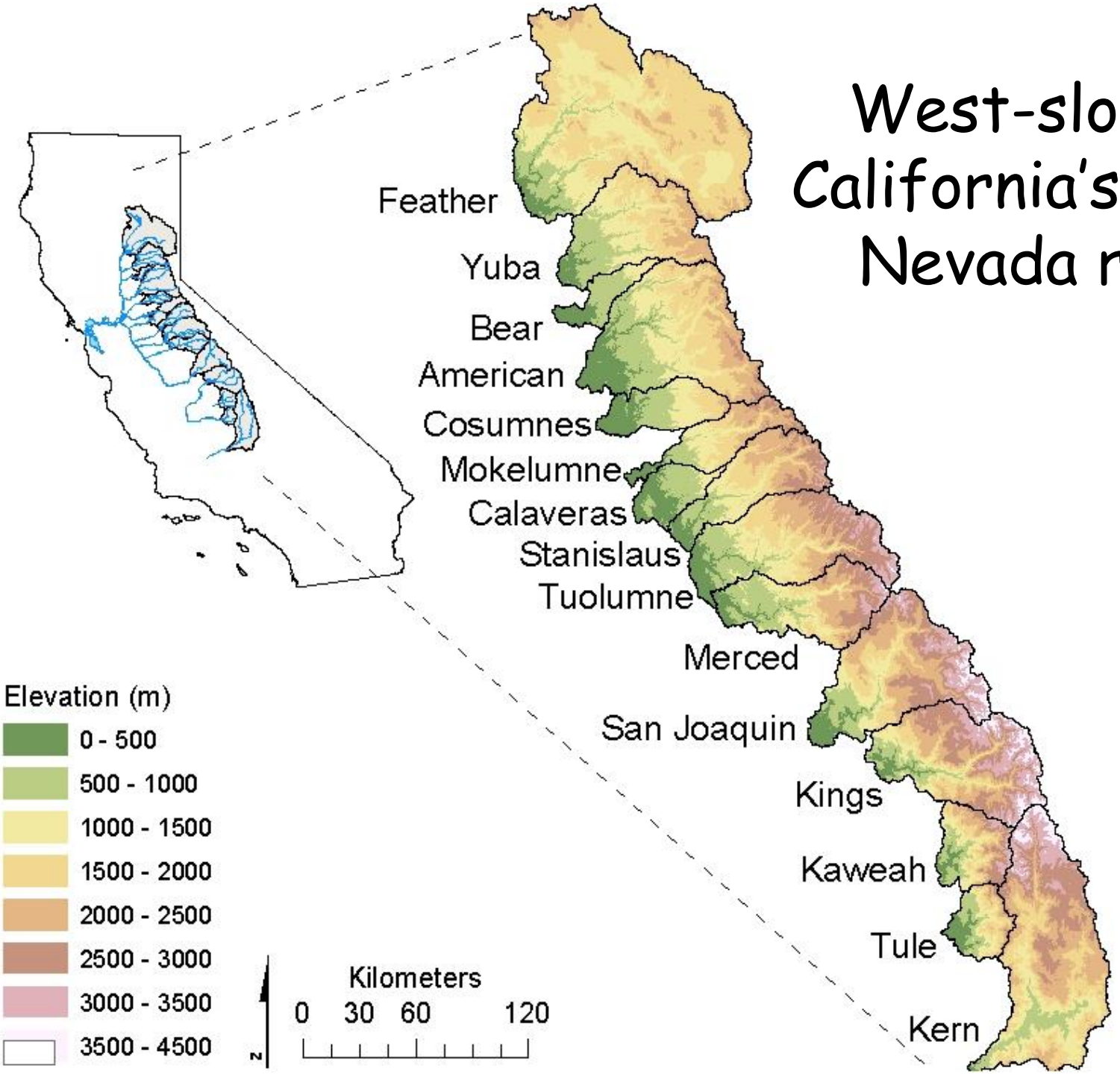
Empirical Model of lake level fluctuations due to changes in precipitation



Wagner, F.H. 1983-84. Rising Salt Lake Level: Fluctuation or portent. Ecotone 11:3-4 (Ecology Center, Utah State University)

Note: Climate change expected to alter runoff more than precipitation

West-slope of California's Sierra Nevada range



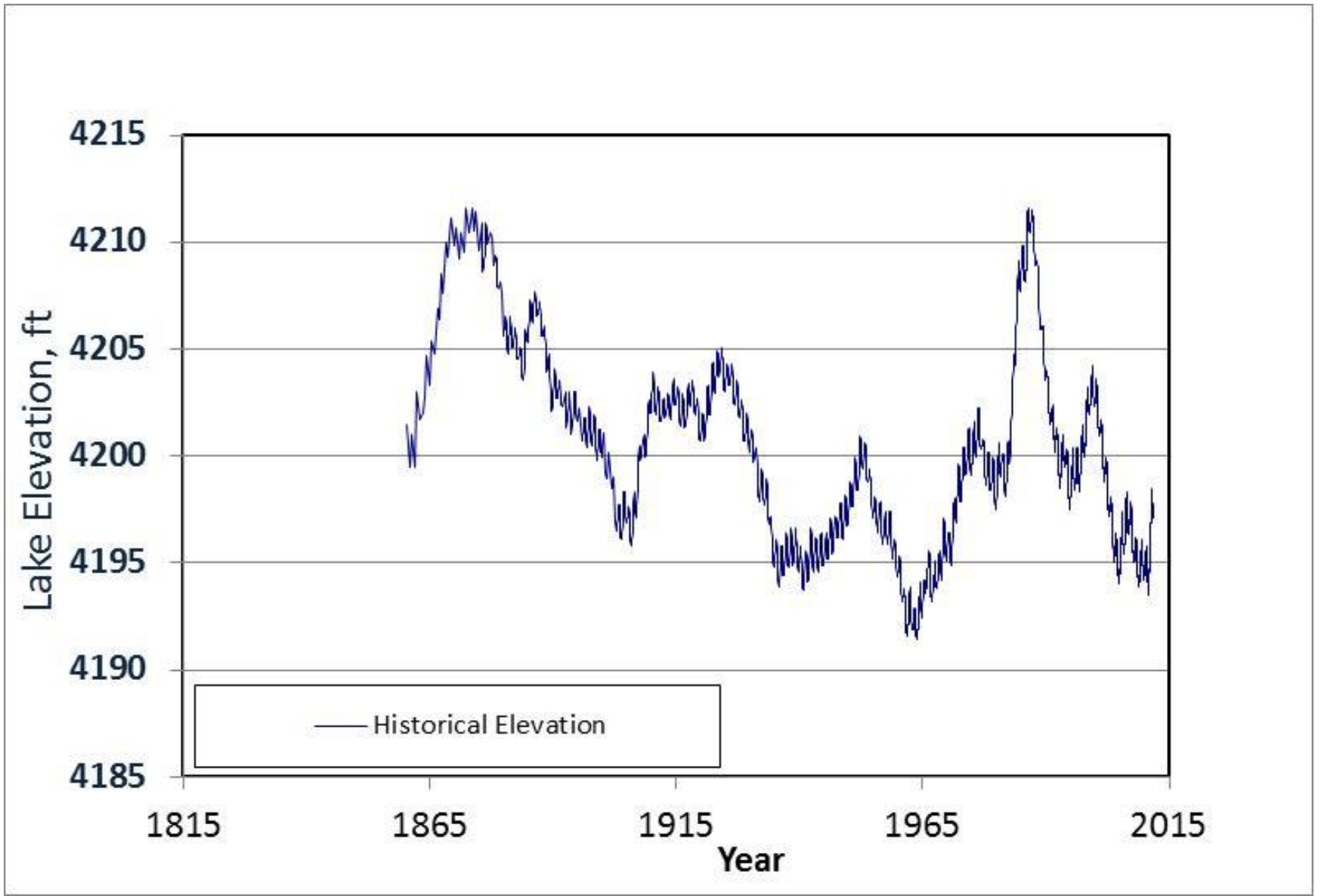
Mean annual flow is reduced in all watersheds with modeled air temperature increases

(T is modeled temperature, with increases of 2, 4, and 6°C)

Watershed	Annual Average Flow (mcm)				Change from Basecase (%)		
	Basecase	T2	T4	T6	T2	T4	T6
Feather	5776	5649	5470	5264	-2.2	-5.3	-8.8
Yuba	3020	2960	2891	2806	-2.0	-4.3	-7.1
Bear	492	475	459	445	-3.6	-6.7	-9.6
American	3556	3448	3332	3218	-3.1	-6.3	-9.5
Cosumnes	603	571	543	518	-5.2	-10.0	-14.0
Mokelumne	979	946	918	887	-3.4	-6.2	-9.4
Calaveras	330	319	310	301	-3.3	-6.3	-8.9
Stanislaus	1561	1523	1482	1435	-2.4	-5.1	-8.1
Tuolumne	2445	2401	2354	2304	-1.8	-3.7	-5.8
Merced	1348	1308	1272	1237	-3.0	-5.6	-8.2
San Joaquin	2294	2265	2235	2201	-1.3	-2.6	-4.1
Kings	2117	2094	2070	2041	-1.1	-2.2	-3.6
Kaweah	586	564	542	519	-3.8	-7.6	-11.5
Tule	199	190	180	171	-4.6	-9.5	-14.3
Kern	926	887	850	813	-4.2	-8.2	-12.2

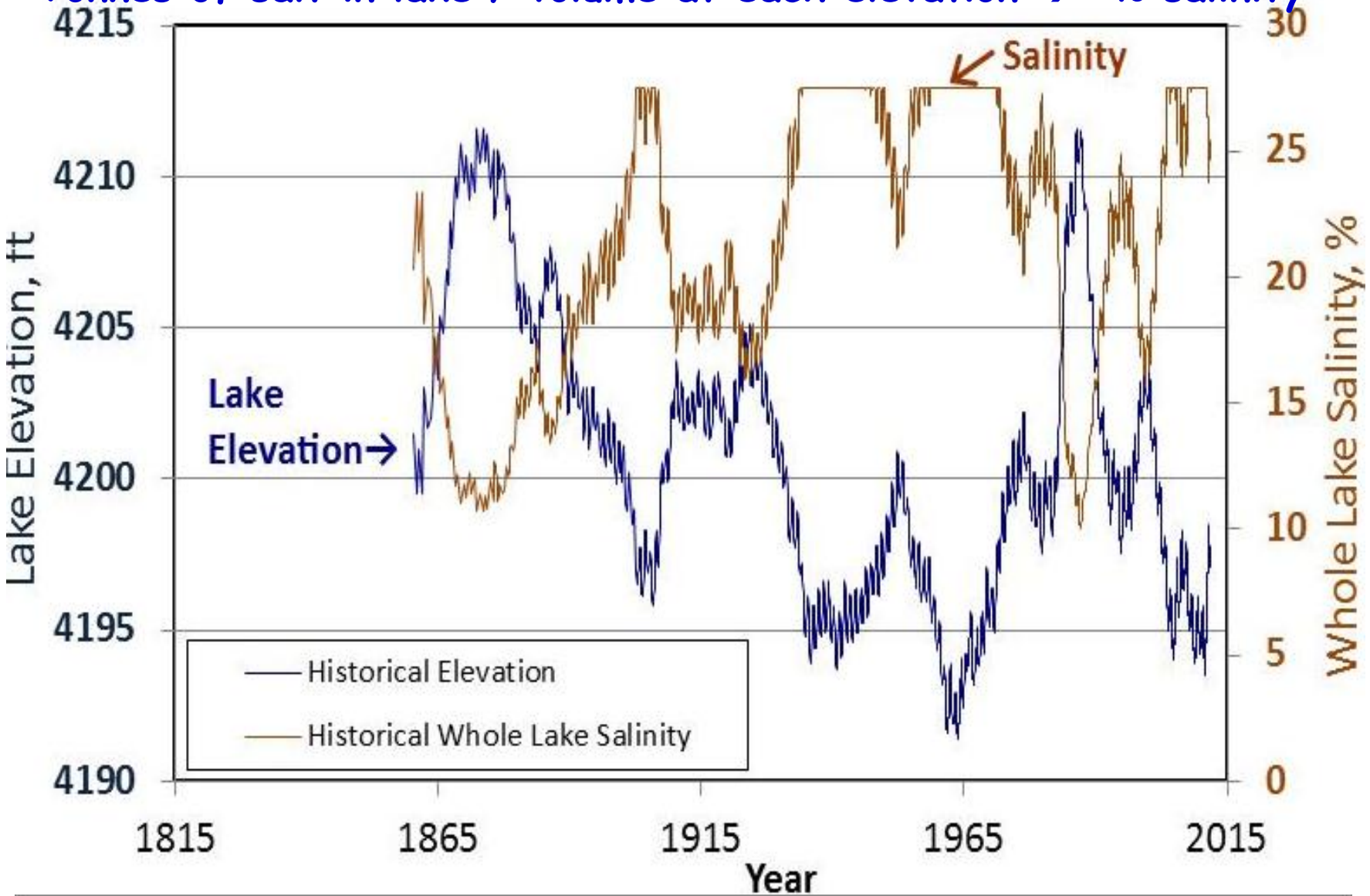
Null et al. 2010. Hydrologic response and watershed sensitivity to climate warming in California's Sierra Nevada. PLoS one, 5(4):e9932

"Whole Lake" Great Salt Lake Elevation

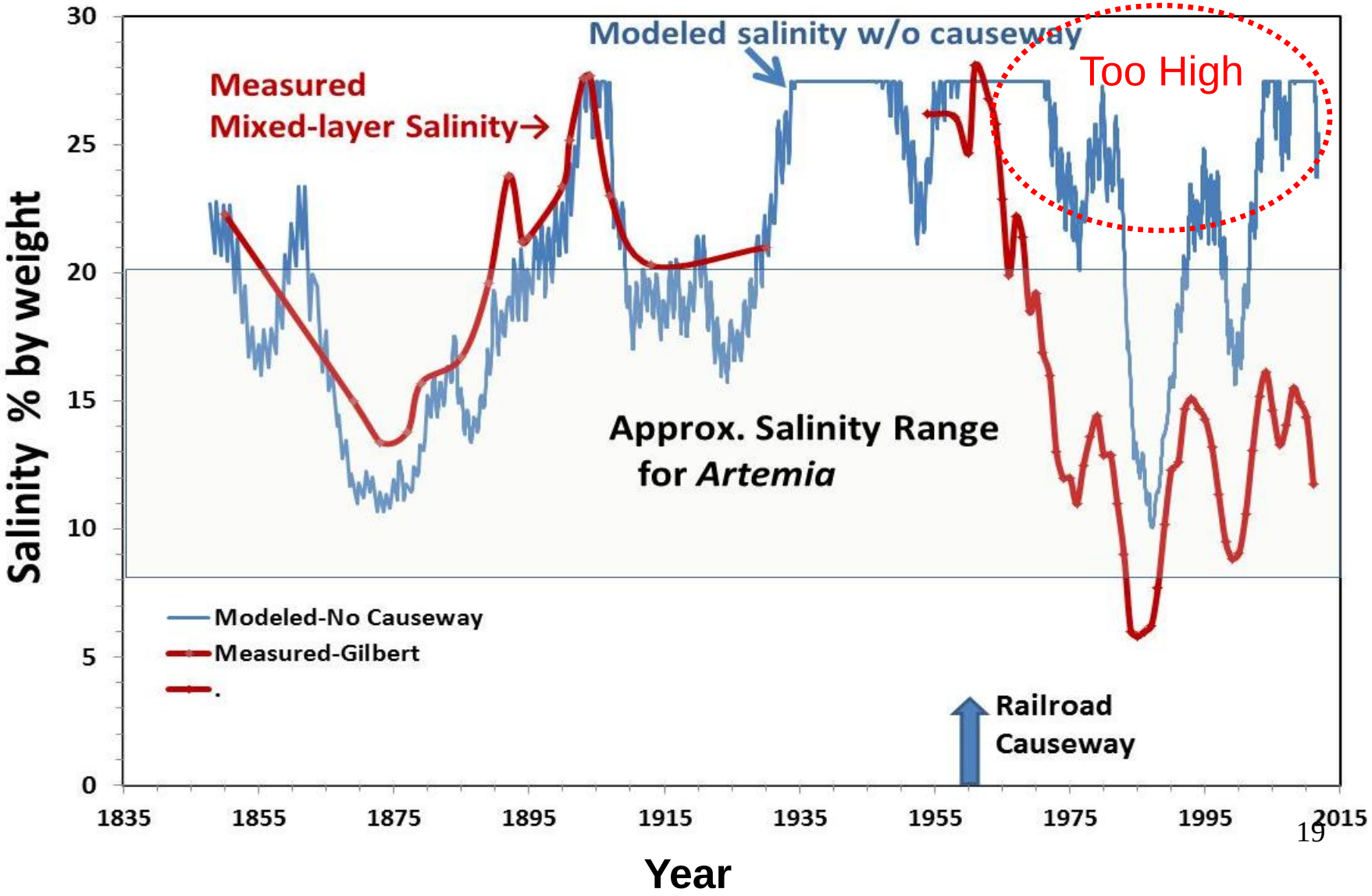


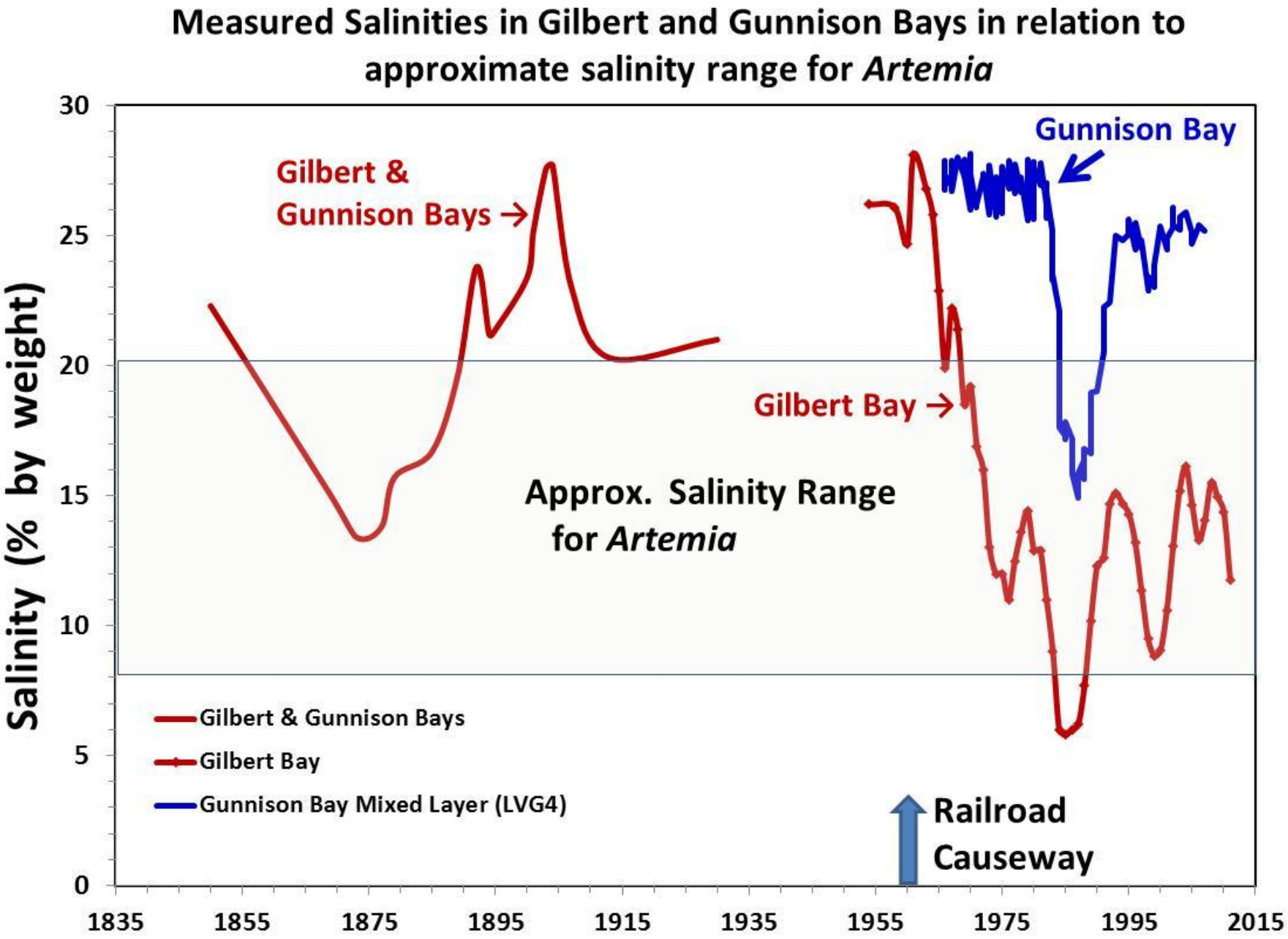
"Whole Lake" (without RR causeway) Great Salt Lake Elevation and Salinity

Tonnes of salt in lake / volume at each elevation → % salinity



Measured Gilbert Bay salinity and estimated "whole lake" salinity if RR causeway not constructed




Measured Salinities in Gilbert and Gunnison Bays in relation to approximate salinity range for *Artemia*
Salinity (% by weight)
30
25
20
15
10
5
0
1835
1855
1875
1895
1915
1935
1955
1975
1995
2015
Gilbert & Gunnison Bays →
Gunnison Bay
Gilbert Bay →
Approx. Salinity Range for *Artemia*
Gilbert & Gunnison Bays
Gilbert Bay
Gunnison Bay Mixed Layer (LVG4)
Railroad Causeway

Causeways gates would allow salt and flow to be managed between Gilbert and Gunnison Bays

Questions?

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